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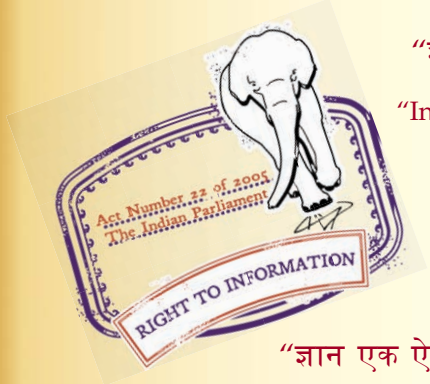
IS 4410-8 (1992): Glossary of terms relating to river valley projects, Part 8: Dams and dam section [WRD 9: Dams and Spillways]



"ज्ञान से एक नये भारत का निर्माण"
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"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS 4410 (Part 8) : 1992
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भारतीय मानक

नदी घाटी परियोजना संबंधी पारिभाषिक शब्दावली

भाग 8 बांध और बांध खंड

(पहला पुनरीक्षण)

Indian Standard

GLOSSARY OF TERMS RELATING TO RIVER VALLEY PROJECTS

PART 8 DAMS AND DAM SECTIONS

(First Revision)

UDC 627·82 : 001·4

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

April 1992

Price Group 9

FOREWORD

This Indian Standard (Part 8) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Terminology Relating to River Valley Projects Sectional Committee had been approved by the River Valley Division Council.

A large number of Indian Standards have already been printed covering various aspects of river valley projects and some more similar standards are in the process of formulation. These standards include technical terms, and precise definitions for these are required for avoiding ambiguity in their interpretation. To achieve this aim, the Terminology Relating to River Valley Projects Sectional Committee is bringing out Indian Standard glossary of terms relating to river valley projects (IS 4410), being published in parts. This Part 8 contains definitions of terms relating to dams and dam sections.

This standard was first published in 1968. The present revision of the standard has been taken up in the light of experience gained during the last 23 years in the use of this standard. In this revision, additional terms have been added besides modifying some of the terms so as to bring them in line with latest technology.

In the formulation of this standard, due weightage has also been given to international co-odination among the standards and practices prevailing in different countries. This has been met by deriving considerable assistance from 'Multilingual technical dictionary on irrigation and drainage', published by International Commission on Irrigation and Drainage (ICID) and other sources.

Indian Standard

GLOSSARY OF TERMS RELATING TO RIVER VALLEY PROJECTS

PART 8 DAMS AND DAM SECTIONS

(First Revision)

1 SCOPE

1.1 This standard contains definitions of terms relating to types of dams, dam sections, galleries, shafts and tunnels, joints and grouting in dam.

1.2 It does not contain terms relating to weirs, barrages and spillways.

2 TYPES OF DAMS

2.1 Arch Dam

A curved solid masonry or concrete dam, convex upstream, that depends principally on arch action for its stability. The water load is mostly transferred by the arch to the canyon walls, or other abutments. It is also called 'Arched Dam'.

2.2 Arch Gravity Dam

A curved solid masonry dam which depends upon both arch action and gravity action for stability. Also called 'Curved Gravity Dam'. Arch gravity dam has the base thickness between 0·5 to 0·6 times the height of dam.

2.3 Articulated Type Buttress Dam

Same as simply supported flat slab deck dam.

2.4 Bag Dam

A low dam made of bags partly filled with soil or boulder concrete. Bags are partly filled to permit flexibility in placement.

2.5 Basket Dam

A dam composed of boulders held in woven wire crates and piled up to form a barrier.

2.6 Beaver Type Dam

A fixed timber dam used for low heads, the bents being of round timbers or logs with butts pointing downstream, spacing logs laid transversely, crevices filled with gravel, covered with a plank deck, the whole structure being fastened together with drift bolts, and to the foundation with anchor bolts. It is seldom used as a permanent structure.

2.7 Boule Dam

A movable dam similar to a Poiree Dam (*see* **2.67**) but with horizontal stop logs or panels instead of needles which span from trestle to trestle.

2.8 Brush Dam

A check dam made of brush wood usually held in place with stakes and wire.

2.9 Bulk Head Buttress Dam

A type of buttress dam (*see* **2.10**) in which the face slab is replaced by flaring the upstream edge of the buttresses to span the distance between buttress walls. The flaring portion may be of various geometrical shapes, namely, (a) massive head; (b) round head or mushroom head; and (c) diamond head. The buttress dams comprising types of head classified above are named accordingly. It is also called 'Round Head Buttress Dam'.

2.10 Buttress Dam

A dam consisting of a water supporting upstream face or deck, usually reinforced concrete slab, supported by buttresses generally in the form of equally spaced triangular reinforced concrete or masonry walls or counterforts, that transmit the water load and weight of the deck to the foundation.

2.11 Cantilever Buttress Dam

A flat deck dam where the slab is cantilevered from the buttresses.

2.12 Cantilevered Steel Dam

See **2.87.**

2.13 Check Dam

A small low fixed dam, constructed of brush, logs, timber, loose rock, masonry, or concrete, in an eroded channel to reduce the slope of the water flowing therein during high stages, and also the resulting velocity, thereby preventing excessive scour and erosion and inducing deposition. A reduction in the size of flood peaks of erosion, and sometimes an increase in low-water flow due to increased ground storage often result from building a check dam. Such dams are also used to retain debris. They usually are built of inexpensive and temporary materials where dependence for ultimate protection is placed on vegetative cover.

2.14 Coffer Dam

It is a temporary structure to exclude water or water and earth from a specific area to facilitate construction.

2.15 Columner Buttress Dam

A type of deck dam in which the massive buttresses are replaced by a series of inclined columns.

2.16 Composite Dam

A concrete/masonry wall with rockfill or earth-backing in downstream.

2.17 Composite Earth Dam

An earth dam consisting essentially of an inner or enclosed impervious section supported by two or more outer sections of relatively pervious material. It is also called 'Multiple Zoned Earth Dam' or 'Zoned Earth Dam'.

2.18 Conoidal Dam

It is a modification of cupola arch buttress dam and has some of the characteristics of the hollow gravity dam and some of those of multiple arch dam. The upstream face is a plane slightly inclined to the vertical; the downstream face is a conoidal surface generated by straight lines, which where they touch the horizontal at the crest are orthogonal there-to and repose on a directrix drawn in a horizontal plane (*see* Fig. 1).

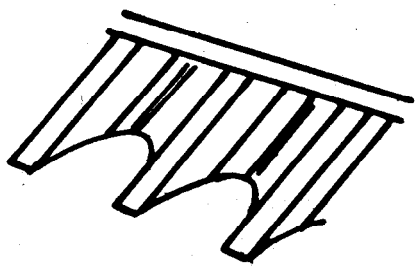

FIG. 1 CONOIDAL DAM

2.19 Constant Angle Arch Dam

It is a special type of variable centre dam in which the central angle of the arches are of approximately the same magnitude at all elevation (*see* Fig. 2).

2.20 Constant Centre Arch Dam or Constant Radius Arch Dam

A type of arch dam whose arch centres for the upstream face and the downstream face are coincident with the axis centre at all elevation. A profile of these centres is a vertical straightline and the arches are of uniform thickness. All cantilevers are of identical shape, varying only in base elevation (*see* Fig. 3).

2.21 Constant Centre Dam

See **2.20.**

2.22 Core-Wall Type Rockfill Dam

A rockfill dam in which a core wall of steel, concrete (plain or reinforced) or compacted earth is placed in the centre, and the rockfill is dumped on both sides.

2.23 Cored Gravity Dam

It resembles hollow gravity dam in principle except that hollows are provided along contraction joints and not in the middle of the section (*see* Fig. 4).

2.24 Cribe Dam

A timber dam consisting of a series of cribs or rectangular cells made of square or round timbers, drift-bolted together, filled with broken rock or boulders, with a upstream facing and deck covered with heavy planks to provide watertightness.

2.25 Cupola Arch Buttress Dam

Here the upstream face of the buttress dam consists of semi-cupolas of ovoidal form of reinforced concrete. Further modification of this dam is conoidal dam.

2.26 Cupola Arch Dam

Same as double curvature arch dam.

2.27 Dam

A barrier constructed across a river or natural watercourse for the purpose of: (a) impounding water or creating reservoir (*see* **2.48**); (b) diverting water there from into a conduit or channel for power generation and or irrigation purpose; (c) creating a head which can be used for generation of power; (d) improving river navigability; (e) retention of debris; (f) flood control; (g) domestic, municipal and induses; (h) preservation of wild life and pisciculture, (j) recreation, etc.

2.28 Debris Dam

A dam built across a stream channel to catch and retain debris, such as sand, gravel, silt and driftwood.

2.29 Detention Dam

A dam whose principal purpose is to temporarily detain all or part of the runoff and enable its release at controlled rates, as and when required.

2.30 Direct-Strutted Steel Dam

A type of steel dam in which the load is transferred from the deck to the foundation through inclined struts (*see* Fig. 5).

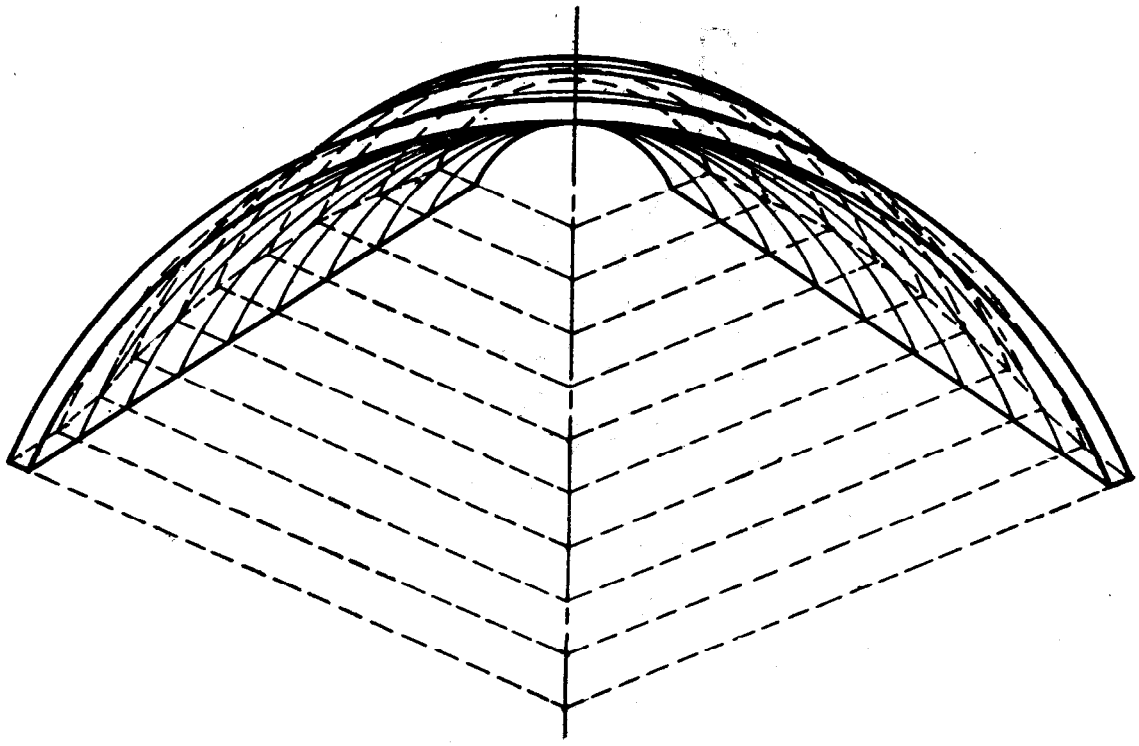

FIG. 2 CONSTANT ANGLE ARCH DAM

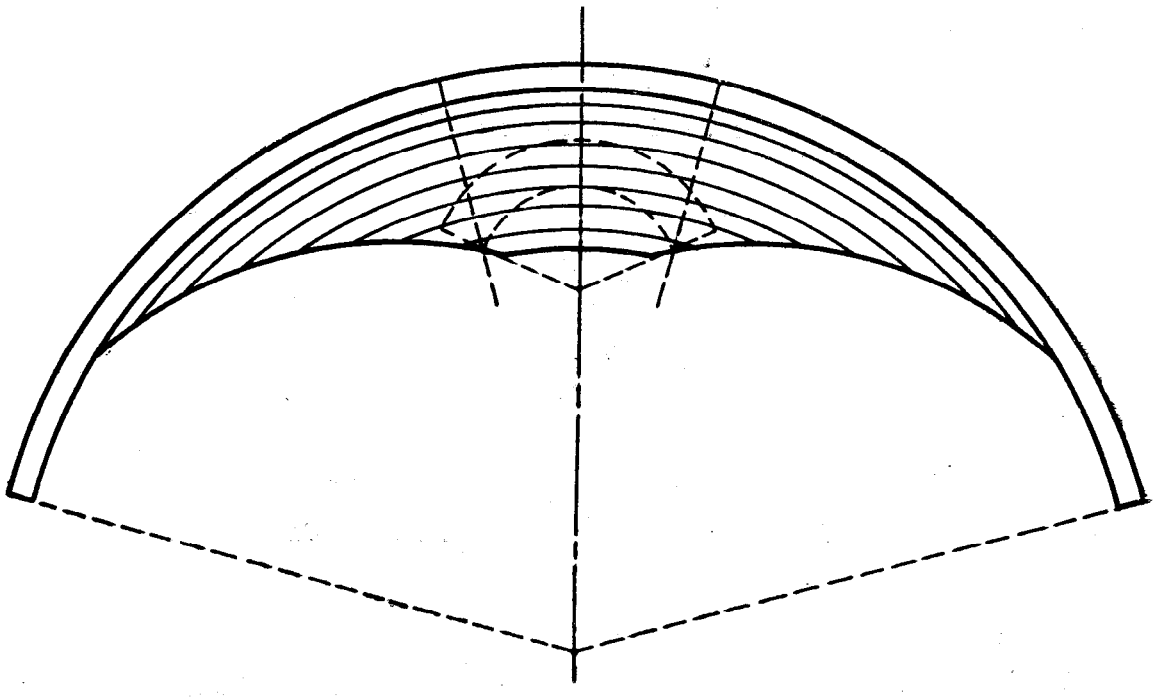

FIG. 3 CONSTANT RADIUS ARCH DAM

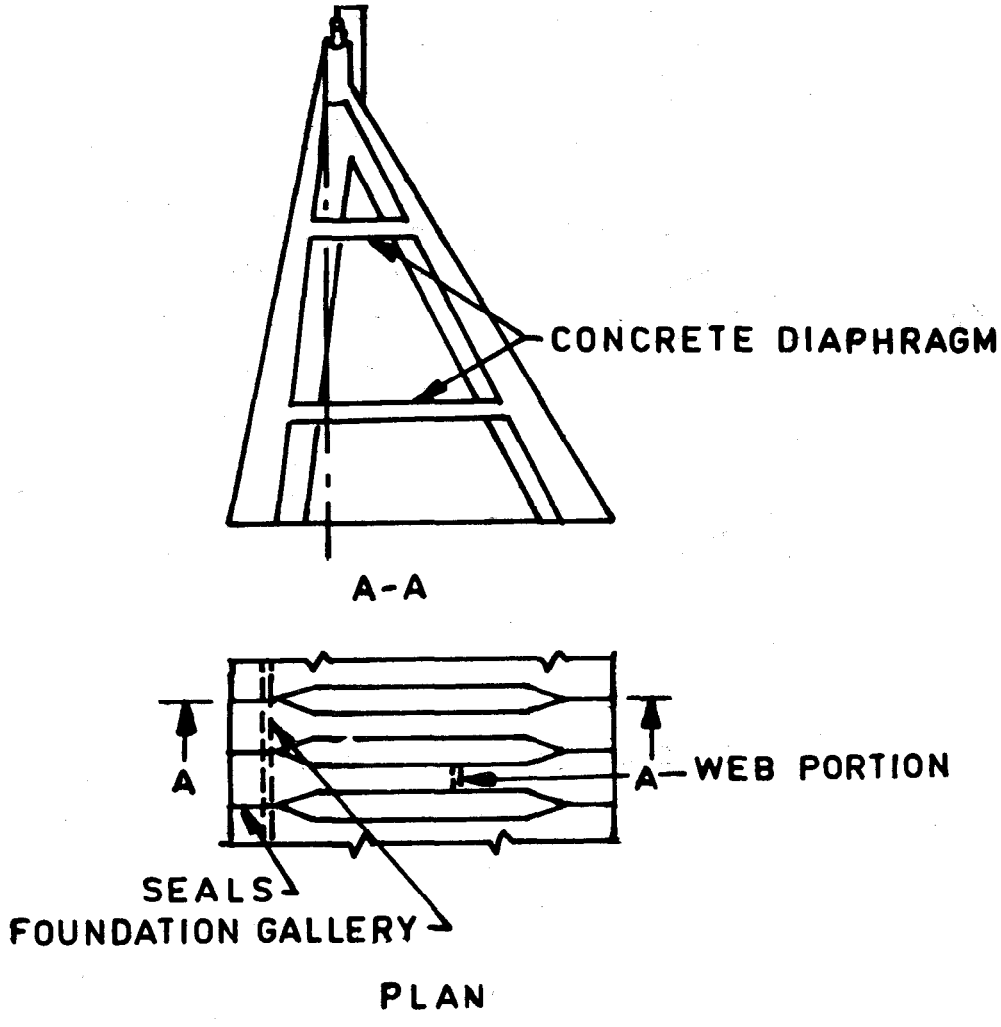

FIG. 4 CORED GRAVITY DAM

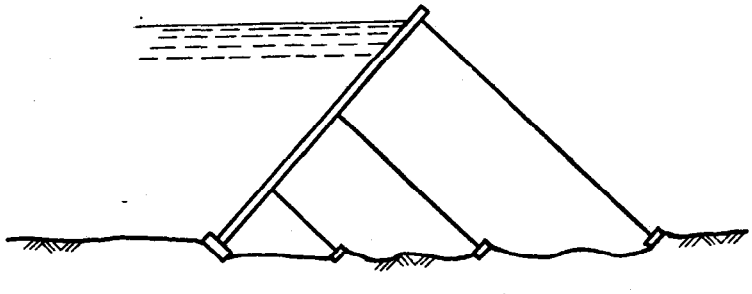

FIG. 5 TYPICAL DIRECT-STRUTTED TYPE STEEL DAM

2.31 Diversion Dam

A fixed dam built for the purpose of diverting part or all of the water from a stream out of and away from its course. It is also called 'Diverting Weir'.

2.32 Dome Dam

A curved masonry, or concrete dam convex upstream that depends principally on dome action for its stability (*see* Fig. 6).

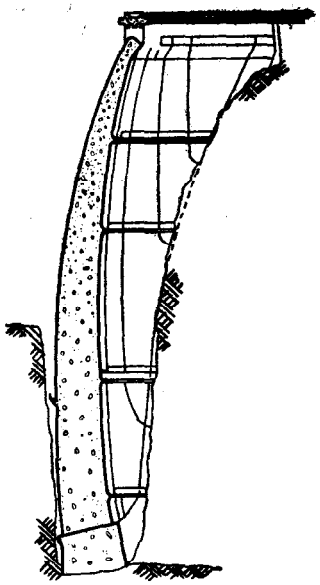

FIG. 6 DOME DAM

2.33 Double Curvature Arch Dam

It is an arch dam which is curved in plan and in elevation with under cutting of the heel and in most instances, downstream overhang near the crest. It is also called 'Cupola Arch Dam'.

2.34 Earth Dam

A dam with the main section composed principally of gravel, sand, silt and clay. It is also called 'Earthen Dam' (*see* Fig. 7).

2.35 Fabri Dam

It is hollow dam of reinforced rubber. The dam is inflated and deflated as required by use of air or water.

2.36 Fixed Deck Dam

A flat deck dam where the slab is integrally cast with the buttress. Also called 'Fixed Slab Buttress Dam'.

2.37 Fixed Slab Buttress Dam

See 2.36.

2.38 Flat Slab Deck Dam

This type of dam is made of a flat reinforced concrete slab, which transmits water pressure to a series of parallel buttress which rest directly on the foundation or upon a concrete slab resting on the foundation material (*see* Fig. 8).

2.39 Framed Dam

A low fixed dam generally built of timber frames to form a water face, supported by struts.

2.40 Free Deck Dam

A flat deck dam where the slab is freely supported on the buttress.

2.41 Gravel Fill Dam

It is a dam composed of gravel or shingle with the downstream part made of relatively coarse material, and the upstream or water side part made of finer gravel and sand.

2.42 Gravity Dam

A solid concrete or masonry dam so designed and shaped that its weight is sufficient to ensure stability against the effects of all imposed forces (*see* Fig. 9).

2.42.1 *High Gravity Dam*

A gravity dam above 90 m in height is called high gravity dam.

2.42.2 *Low Gravity Dam*

A gravity dam less than 30 metres in height is called low gravity dam.

2.42.3 *Medium Height Gravity Dam*

A gravity dam between 30 metres and 90 metres in height is called medium height gravity dam.

2.43 Hollow Base Dam

Same as hollow gravity dam, where a big cavity is left only in the bottom portion of a gravity dam.

2.44 Hollow Dam

A modification of buttress dam in which the buttresses are grouped or joined together leaving hollow spaces.

2.45 Hollow Gravity Dam

It is a structural refinement of the solid gravity dam in which some concrete from the low stress areas of solid dam is removed to reduce uplift pressure and a slop is provided to upstream face of the dam to take advantage of the water load for improving stability. The base is also widened in direction of the thrust to improve stability against overturning and sliding (*see* Fig. 10).

2.46 Homogeneous Earth Dam

An earth dam composed of a single type of material, except for protective material on the exposed faces.

2.47 Hydraulic Fill Dam

An earth dam, in the construction of which all or most of the materials have been transported by agency of water to the dam and placed in the dam by dredging, sluicing, or pumping. Generally, for greater imperviousness, the fine material in the sluiced earth is segregated and deposited along the centre of the dam to form a core.

2.48 Impounding Dam

See 2.27.

2.49 Large Dam

A dam above 15 m in height measured from the lowest portion of the general foundation area to the crest or a dam between 10 m and 15 m in height, provided it complies with at least one of the following conditions:

a) The length of crest of the dam to be not less than 500 m;

b) The capacity of reservoir formed by the dam to be not less than 1 million m^3;

c) The maximum flood discharge dealt with by the dam to be not less than 2 000 m^3/sec;

d) The dam had specially difficult foundation problems;

e) The dam is of unusual design.

2.50 Landslide Dam

An obstruction formed in the stream flow due to natural causes, like huge rockfalls, landslides, or snow avalanche from the side slope resulting in complete or partial blockade.

2.51 Levee

An earthen embankment extending generally parallel to river channel and designed to protect the area behind it from overflow by flood waters.

2.52 Loose Rock Dam

A dam constructed of variable size rocks, without mortar, usually dumped in place without any particular effort at packing sorting or arranging.

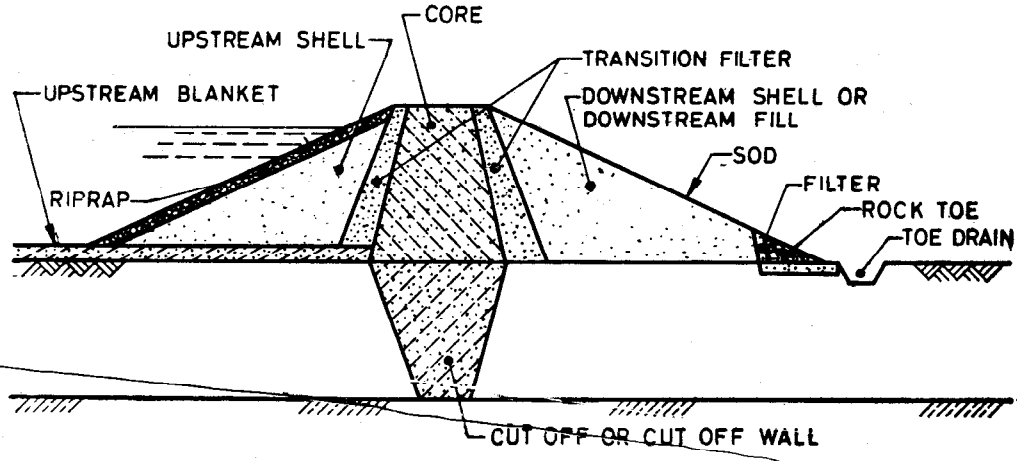

FIG. 7 TYPICAL EARTH DAM

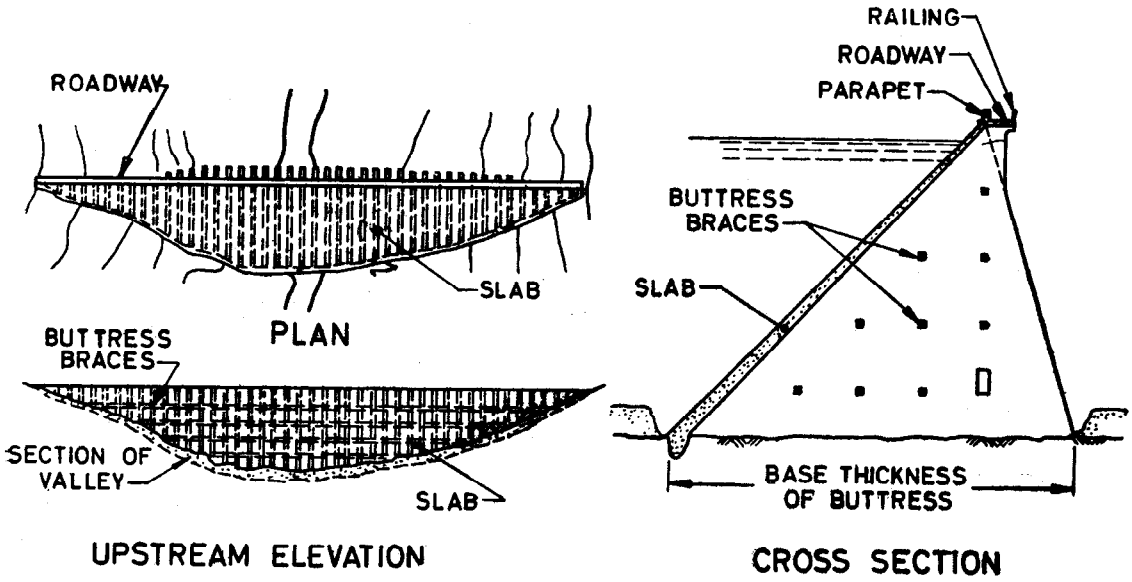

FIG. 8 FLAT SLAB DECK DAM

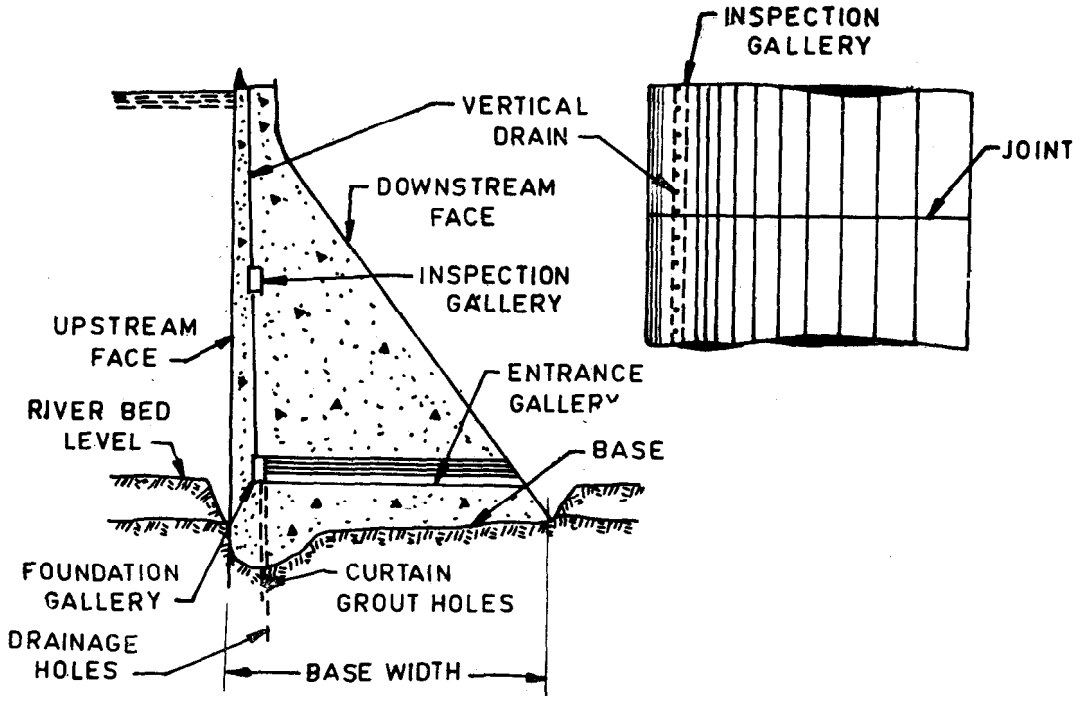

FIG. 9 GRAVITY DAM

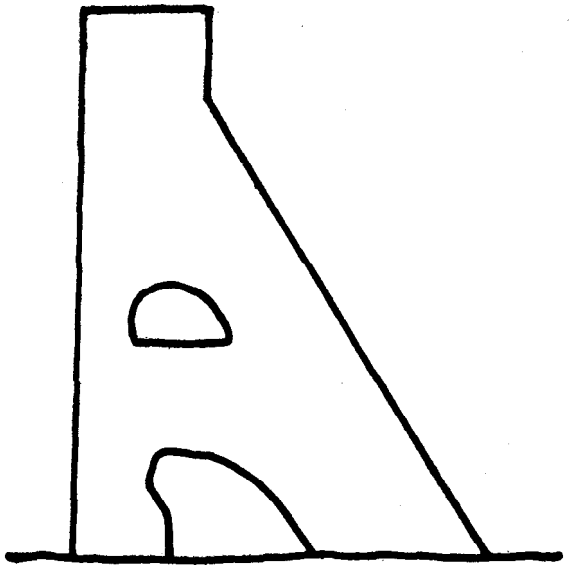

FIG. 10 HOLLOW GRAVITY DAM

2.53 Lifting Dam

A dam of any type of construction meant to raise the water level for diversion purposes without any appreciable storage.

2.54 Masonry-cum-Earth Dam

A dam comprising portion of earth and masonry along its length (spillway, not included).

2.55 Masonry Dam

A dam composed of one or more of the following material brick or stone masonry.

2.56 Massive Head Buttress Dam

See 2.9.

2.57 Medium Arch Gravity Dam

It is an arch dam where the thickness of base is between 0·2 times to 0·3 times the height.

2.58 Modified Homogeneous Earth Dam

An earth dam, in which small amounts of pervious material selected to control the action of seepage are suitably incorporated in an otherwise homogeneous dam.

2.59 Multiple Arch Dam

A buttress dam composed of a series of inclined arches supported by buttresses or piers. The load is transferred from the arches to the foundation through the buttresses (*see* Fig. 11).

2.60 Multiple Dome Buttress Dam

A buttress dam in which massive buttresses spaced far apart support a set or series of domes on which the water rests (*see* Fig. 12). It is also called, 'Multiple Dome Dam'.

2.61 Multiple Dome Dam

See 2.60.

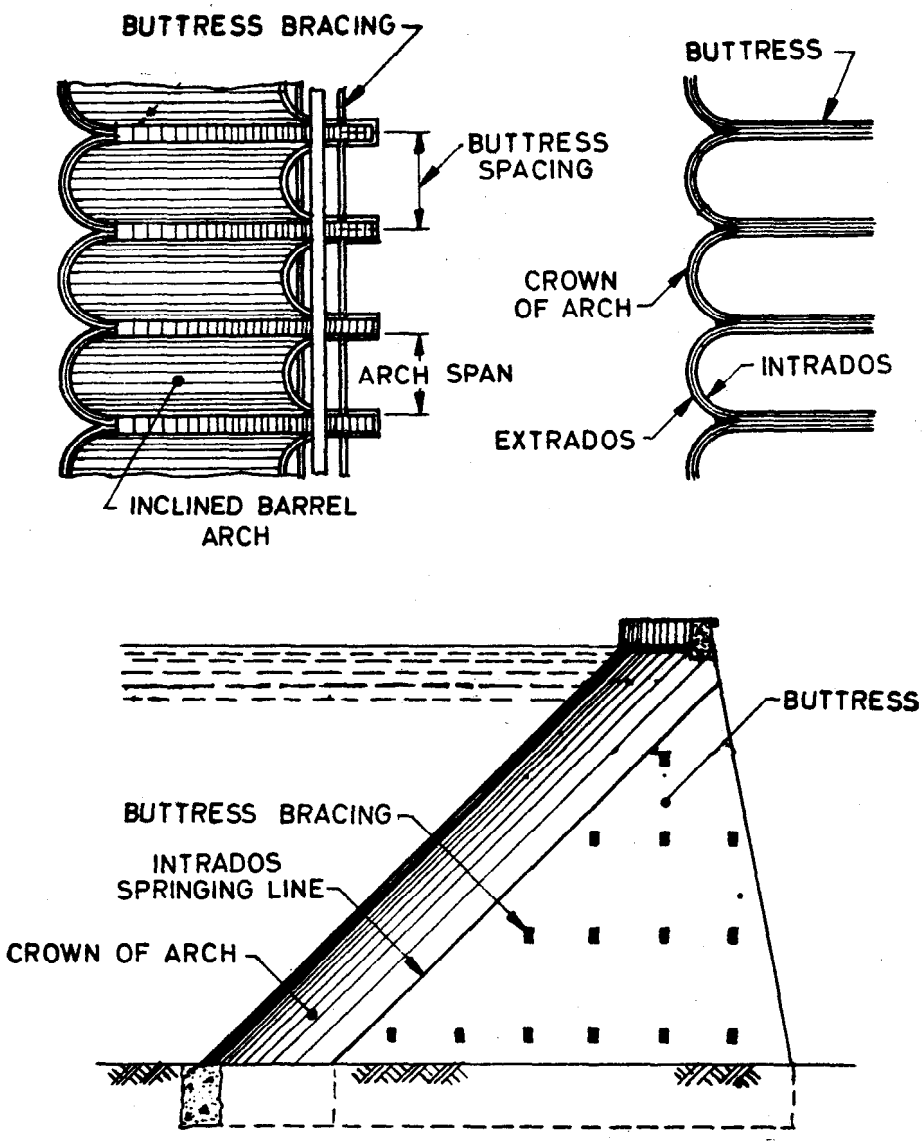

FIG. 11 MULTIPLE ARCH DAM

2.62 Multiple Zoned Earth Dam

See **2.17.**

2.63 Non-Over Flow Dam

The dam portion which does not allow to escape flood waters by overtopping is called non-overflow dam.

2.64 Non-Rigid Dam

A dam constructed with non-rigid materials or materials like earth rockfill, etc.

2.65 Overfall Dam

A dam constructed with a crest to permit the overflow of water. Also called 'Overflow Dam' and 'Spillway Dam'.

2.66 Overflow Dam

See **2.65.**

2.67 Poiree Dam

A dam consisting of a curtain of timber needles supported at the bottom by a sill and at the top by a beam carried by moving steel trestles.

2.68 Poly-Centered or Three-Centered Dams

These dams are variable centre dams in which the location of centres and radii associated with them also vary horizontally to produce dams with elliptically shaped or multicentered arch elements.

2.69 Prestressed Dam

A dam comprising of concrete which, by post-tensioning with high tensile steel bars or wires, increases the initial compressive stress in the upstream portion of the dam allowing for thinner cross section than those for gravity dams. The post-tensioning bars or wires are arranged in groups, and located in holes or shafts, and are anchored into the foundations (shaft anchorage) (*see* Fig. 13).

2.70 Rigid Buttress Dam

A dam having upstream water supporting members constructed monolithically with the buttresses with no provisions for unequal foundation settlement or for expansion and contraction between adjacent bays. Examples of the rigid type are multiple arch and continuous deck type (*see* Fig. 14).

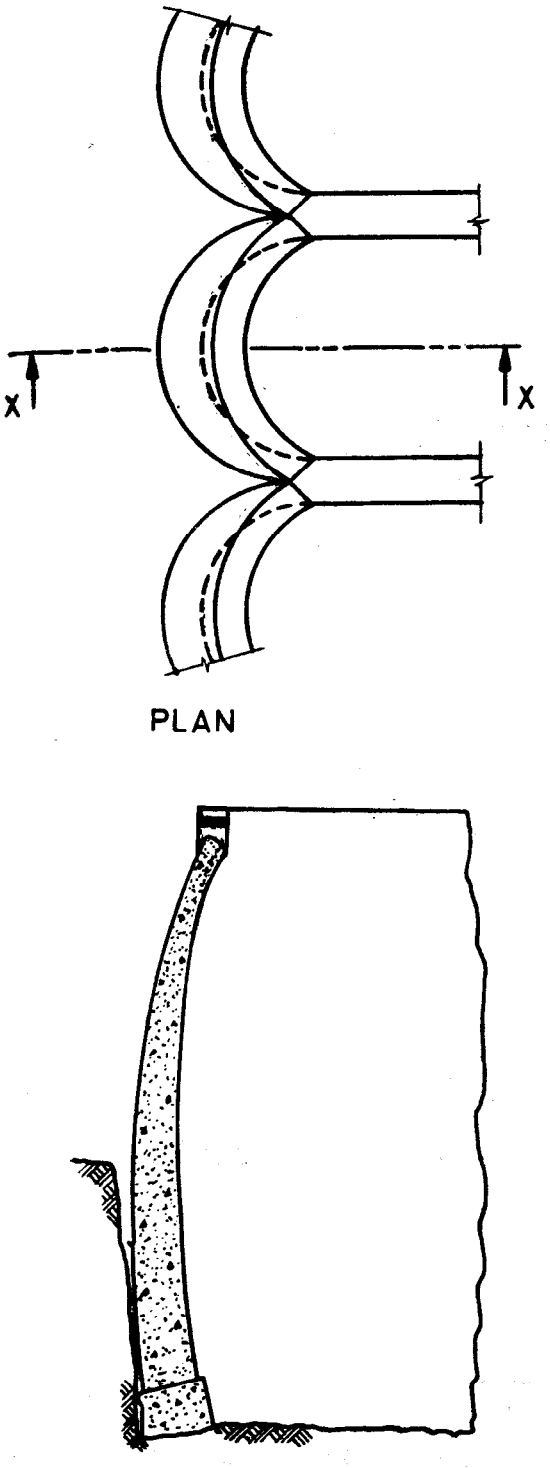

FIG. 12 MULTIPLE DOME DAM

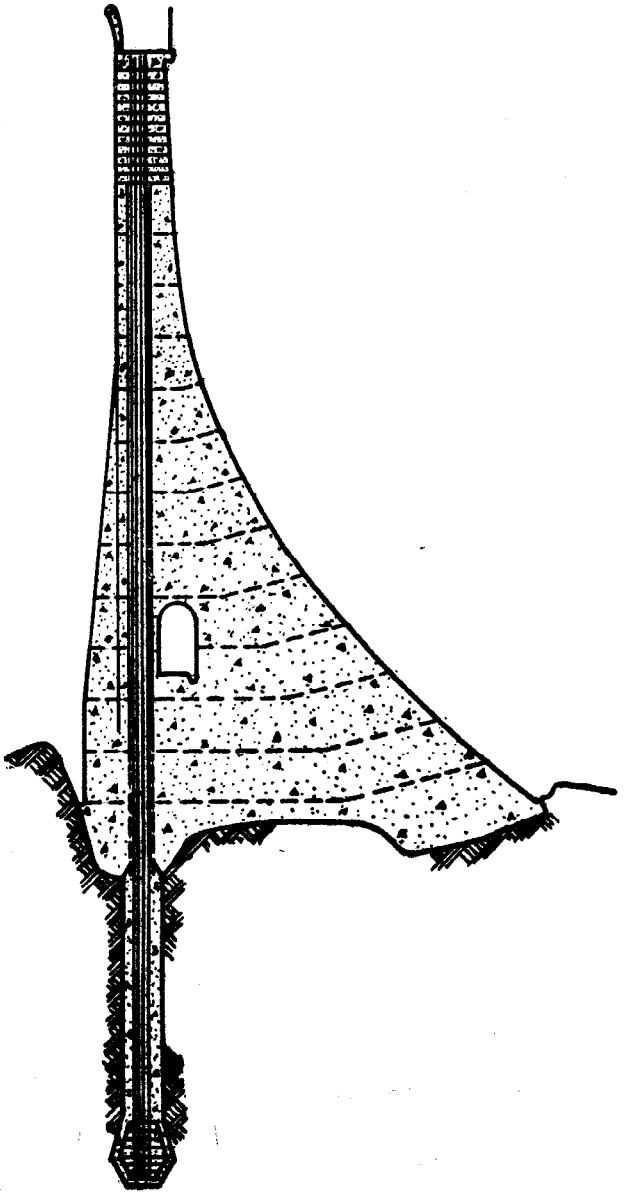

FIG. 13 A TYPICAL PRESTRESSED DAM

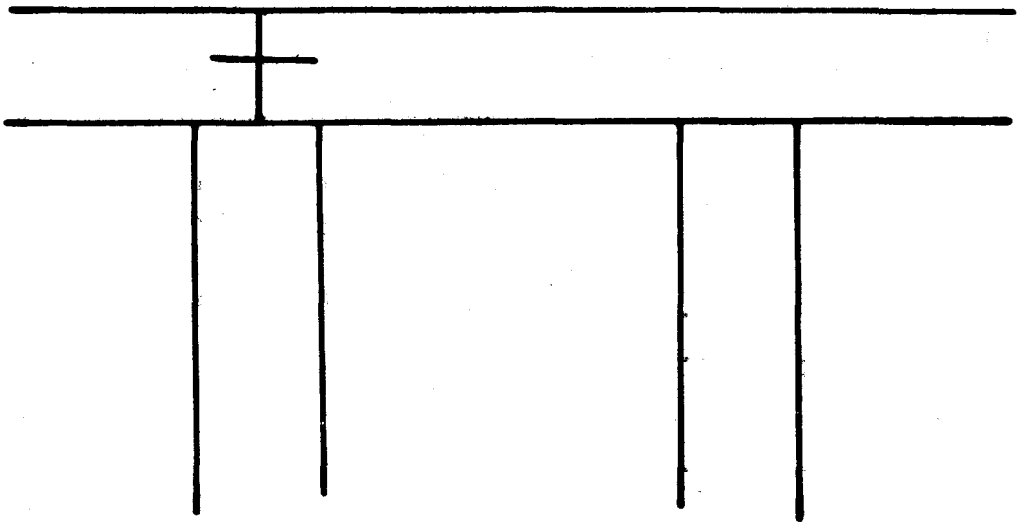

FIG. 14 RIGID BUTTRESS DAM

2.71 Rigid Dam

A dam constructed with rigid material such as masonry, concrete, steel or timber.

2.72 Rockfill Composite Dam

A rockfill dam consisting of a rockfill on the downstream side and an earthfill on the upstream side; the former for stability principally, the latter for both imperviousness and stability.

2.73 Rockfill Dam

A dam composed of rock, either dumped in lifts or compacted in layers as a major structural element. An impervious membrane is used as the water barrier and can be placed either within the embankment or on the upstream slope (*see* Fig. 15).

2.74 Rolled Earth Dam

A dam in which selected materials are placed in thin layers and compacted by rolling at proper moisture content. It can be a zoned earth dam or a homogeneous earth dam.

2.75 Rolling Dam

A movable dam consisting of a large steel cylinder placed across the waterway between piers of abutments and arranged to be rolled up clear of the stream flow on an inclined rack track.

2.76 Round Head Buttress Dam

See **2.9**.

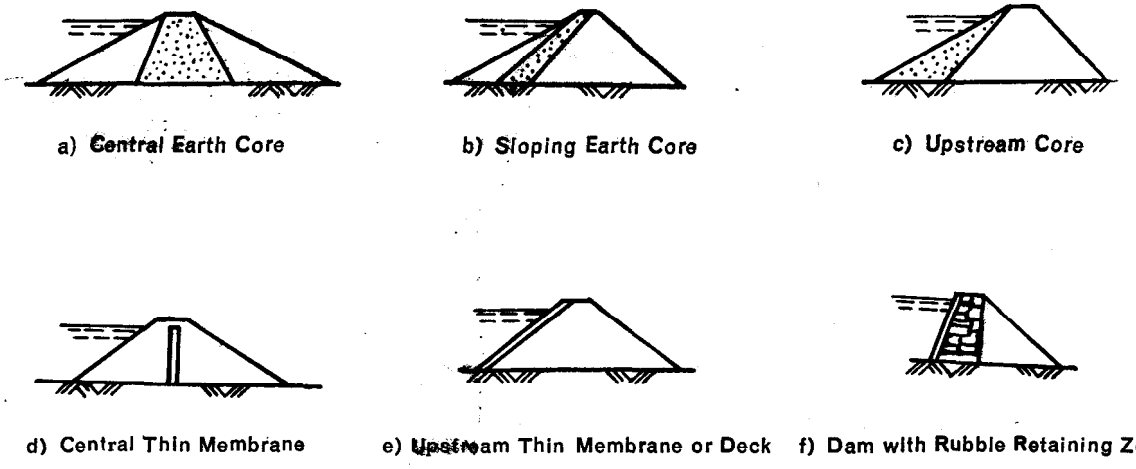

FIG. 15 ROCKFILL DAM TYPES

2.77 Rubble Dam

A dam constructed of rocks laid in place, without mortar.

2.78 Sausage Dam

A low dam constructed of cylinders of loose rock formed by wirenet wrapping. The cylinders are laid in either a horizontal or a vertical position. Such dams are not impervious and are used primarily to reduce erosion, retard debris, etc.

2.79 Semihydraulic Fill Dam

An earth dam in the construction of which the material has been transported by some means other than water, and some of it has been moved into place by the agency of water.

2.80 Semirigid Dam

An intermediate class of dam between rigid and non-rigid type like rockfill dam.

2.81 Single Centred Dams

These dams have one set of lines of centre on the reference plane. Both sides of each face are described by the same circular arc.

2.82 Single Curvature Dam

An arch dam which is curved in plan only.

2.83 Small Dam

A dam less than 15 m in height and which does not fulfil any of the conditions of a large dams.

2.84 Solid Gravity Dam

See **2.42**.

2.85 Spillover Buttress Dam

Where flood water is allowed to be passed over, buttress (*see* Fig. 16).

2.86 Spillway Dam

See **2.65**.

2.87 Steel Dam

A dam built of steel deck supported on inclined steel struts. There are two general types of this dam: (a) 'Direct-Strutted Steel Dam' (*see* **2.30**) in which the load is transferred from the deck to the foundations through inclined struts (*see* Fig. 5), and (b) 'Cantilevered Steel Dam' (*see* **2.12**), which consists of variations of the direct strutted type, in which the section of the bent supporting the upper part of the deck is formed into a cantilever truss (*see* Fig. 17).

2.88 Storage Dam

This dam impounds water in periods of surplus supply for use in periods of deficient supply. These periods may be seasonal, annual or longer.

2.89 Straight Gravity Dam

A gravity dam straight in plan.

2.90 Thick Arch Dam

It is an arch dam where the thickness of base is between 0·3 times to 0·5 times the height.

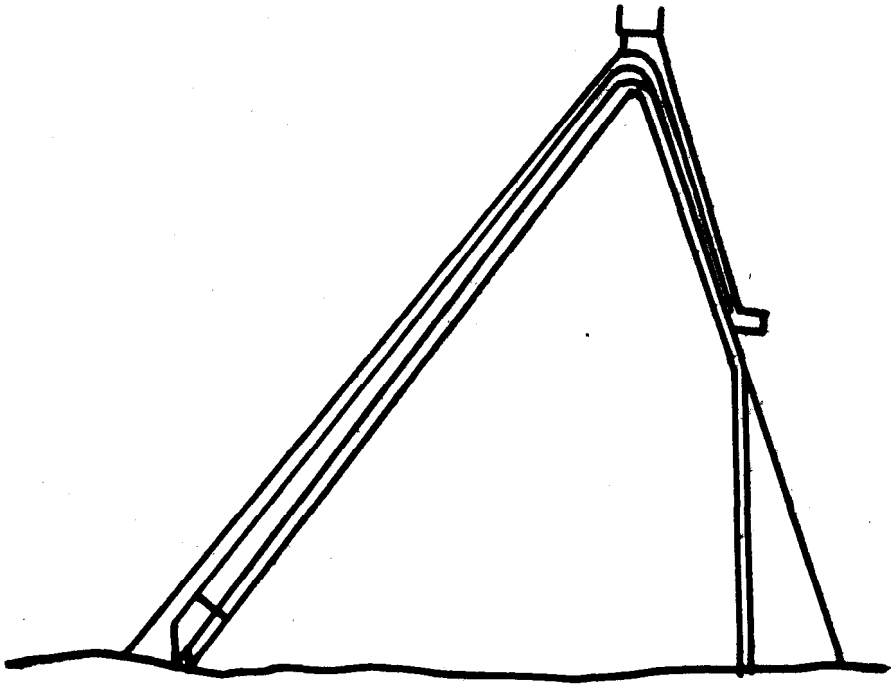

FIG. 16 SPILL OVER BUTTRESS DAM

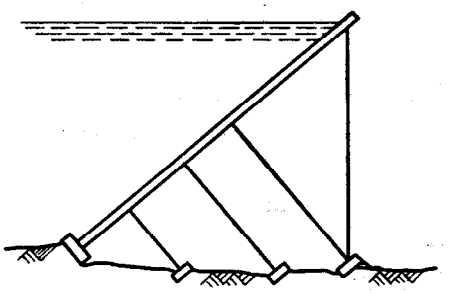

FIG. 17 TYPICAL CANTILEVER TYPE STEEL DAM

2.91 Thin Arch Dam

It is an arch dam where the thickness of base is less than 0·2 times the height.

2.92 Tilting Dam

An overflow dam so constructed that a top section will tilt and allow the passage of excess water; sections are set to tilt at various elevations of the impounding water.

2.93 Timber Dam

A dam constructed of framed timbers. The dam may be of cellular or crib construction, filled with rock to give it stability, or it may attain such stability through its form of design.

2.94 Timber A-Frame Dam

A fixed dam, usually low in height, built of squared timbers with a plank facing, and not filled with rock. The bents or buttresses are framed like the letter 'A' lying on its side, with apex upstream, one side forming a sill and the other the support for the deck. The deck usually makes an angle of less than 30 degrees with the horizontal.

2.95 Truss Buttress Dam

A type of deck dam in which the massive buttresses are replaced by reinfored concrete trusses to support the deck slab.

2.96 Two-Centered Dam

These dams have two sets of lines of centres, one set for each side of the dam. The two sets are coplanear on the reference plane. Each face of an arch element is described by two circular arcs compounded at the reference plane.

2.97 Variable Centre Dam

An arch dam whose arch centres for either or both the upstream face and the downstream face vary in location with respect to axis centre at different elevations. The arches may be of uniform thickness or variable thickness with or without fillets. Cantilevers vary in shape and thickness at different locations within the dam according to the difference in curvature between the arches and according to the kind of arches used (*see* Fig. 18).

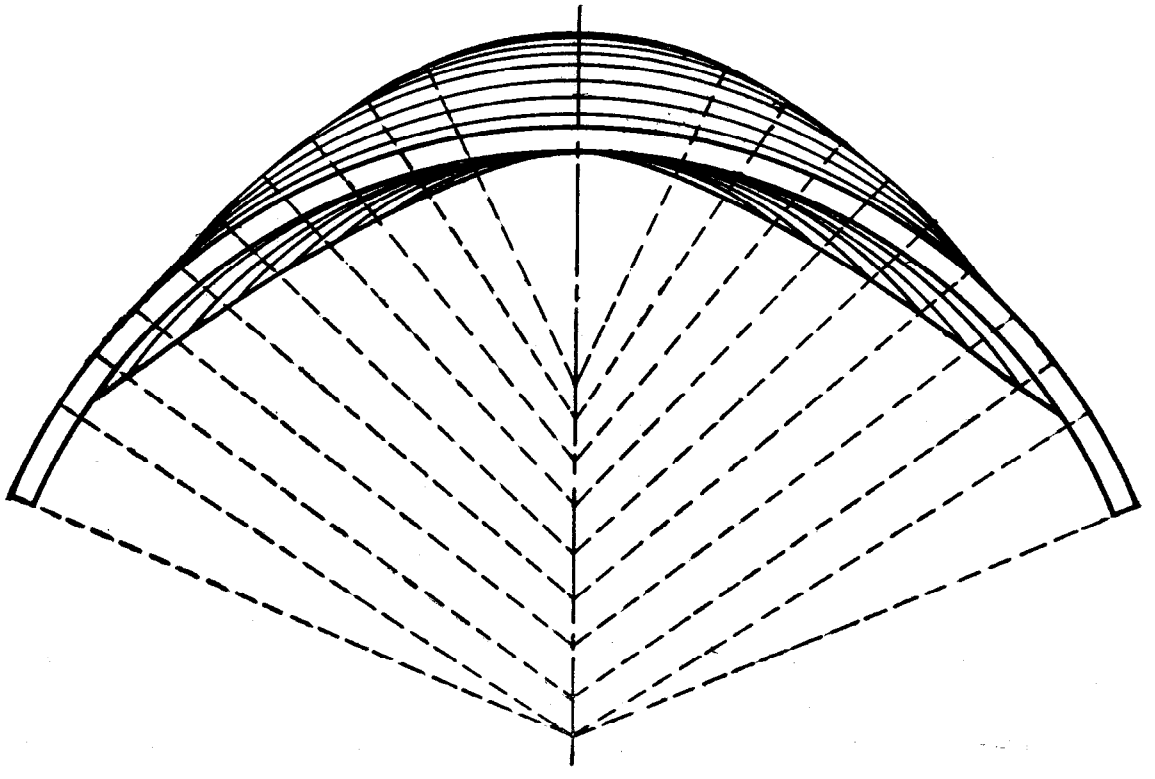

FIG. 18 VARIABLE CENTRE DAM

2.98 Variable Radius Arch Dam

See 2.97.

2.99 Wicket Dam

A movable dam consisting of a sill and a number of wickets or rectangular panels of wood or iron, hinged on the sill and held up nearly vertical by a hanged prop that has a footing on the sill and can be tripped, dropping the wickets flat on the sill.

3 TERMS RELATING TO DAM SECTIONS

3.1 Abutment of a Beam Element

It is the surface at either end of the beam, which contacts the rock of the canyon wall.

3.2 Abutment Pads

It is a structure between arch dam and their foundations.

3.3 Apron

A floor or lining of concrete, timber, stone, etc, to protect a surface from erosion, such as the pavement below chutes, spillways, or the toe of dam.

3.4 Arch Abutment

The abutment of an arch element is the surface at either end of the arch, which contacts the rock of the canyon wall. Arch loads are transferred through the arch abutments to the canyon walls.

3.5 Arch Cantilever Section

It is a vertical section taken normal to the extrados usually oriented with the reservoir on the left.

3.6 Arch Centre Line

The locus of all median points of the thickness of an arch section.

3.7 Arch Element

An arch element, or arch, is a portion of a dam bounded by two horizontal planes at distances of one unit apart.

3.8 Arch Section

A section representative of an arch dam as it would appear if cut by a horizontal plane.

3.9 Axis

See 3.10.

3.10 Axis of Dam

The plane or curved surface arbitrarily chosen by the design or approach as a line in plan or in cross section to which the horizontal dimension of the dam can be referred.

3.11 Beam Element or Beam

It is a portion of a gravity dam bounded by two horizontal planes one metre apart.

3.12 Beam Section

A horizontal section through the dam.

3.13 Bedrock

Any *in-situ* rock underlying the overall burden material.

3.14 Blanket

A cover of pervious, semi-pervious or impervious material.

3.15 Blanketing

The covering of one type of material by a layer of another type of material.

3.16 Bucket

a) A curved surface provided at the toe of an overflow dam to deflect the overflowing water in such a manner as to reduce erosion at the toe of dam.

b) The transition curve between the downstream face of an overflow dam and its apron.

3.17 Cantilever Elements

The cantilever element, or cantilever, is that portion of a dam, which is contained within two vertical radial planes or two vertical planes normal to the dam axis spaced a unit distance apart at the axis. Cantilevers of arch dams, other than one of the constant-centre type, have warped sides owing to the fact that the arch centre line radii are not the same at all elevations. The crown cantilever is located at the point of maximum depth.

3.18 Cantilever Section

It is a vertical section taken normal to the axis, usually oriented with the reservoir on the left.

3.19 Canyon or Canon

A deep valley with high steep slopes generally with a stream at the bottom. Canyons are characteristic of regions where, owing to aridity or to great slope, the downward cutting of the stream greatly exceeds weathering. The width at the top is generally several kilometres and at the bottom about that of the stream distinguish by its great size and rugged steep slopes.

3.20 Canyon Shape

Same as 'Valley Shape'.

3.21 Canyon Shape Factor

It is the ratio of the perimeter of the foundations and abutments of a dam measured along its axis and the maximum height of the dam.

3.22 Canyon Wall

It is the side face of the long narrow canyon valley along which the dam abutts.

3.23 Central Angle of Arch Dam

Central angle of arch is the angle bounded by lines radiating from the arch extrados centre to points of intersection of the arch centre line with the abutments (*see* Fig. 2).

3.24 Construction Sluice

It is an opening through the body of the dam for passing or diverting water during the construction period of dam.

3.25 Control House

A structure usually built at the top of the shaft and employed as a means of access to the gate chamber. The house usually shelters the remote control mechanism, a hoist, generator set, ventilating system, heater, gate height indicator, etc.

3.26 Core

A wall of concrete or masonry, sheet piling, or compacted puddled clay built inside an earth or rockfill dam to reduce percolation. It is also called 'Core Wall' (*see* Fig. 7).

3.27 Core Wall

See **3.26.**

3.28 Crest

The line or area defining the top of the dam or the overflow section of a spillway.

3.29 Crest Length

The length as measured along the crest of the dam.

3.30 Crest Lavel

The elevation of the crest of a dam above mean sea level.

3.31 Cutoff

A wall or diaphragm of concrete or steel, or a trench filled with impervious earth or grout curtain, extending into the foundation of a dam, and either making a watertight connection with the dam or its impervious facing or extending into the body of the dam a considerable distance; its purpose is the prevention or reduction of passage of water under the dam and the foundation material or through the upper layers of the foundation material (*see* Fig. 7).

3.32 Cutoff Buttress

Cross walls projecting into embankment from spillway abutments, power-house walls, or other concrete walls extending through the structure in an upstream and downstream direction.

3.33 Cutoff Collars

In all closed conduit layouts, seepage of water along the contact plane of the outlet conduit and the dam embankment is minimized by the construction of projecting fins or cutoff collars around the exterior circumference of the conduit particularly through the upstream and the central portion of the impervious section of the dam.

3.34 Cutoff Trench

An excavation in the base of a dam to be filled with relatively impervious material to reduce percolation through the foundation.

3.35 Cutoff Wall

See **3.31.**

3.36 Dam Axis

See **3.10.**

3.37 Downstream Projection

It is the horizontal distance from the intrados to the axis on a line normal to the extrados.

3.38 Downstream Shell or Downstream Fill

See **3.84.**

3.39 Downstream Toe

Junction of the downstream slope or face of a dam with the ground surface or downstream river bed.

3.40 Drainage Wells

Openings between the watertight arches and the supporting mass in a dam with levy-type facing.

3.41 Drainage Filter

See **3.55.**

3.42 Drain Well

A deep cylindrical drain located in the foundations of a dam or downstream of it to relieve the seepage pressures in pervious strata too deep to be reached by trench drains, and to drain localized concentrations of seepage, where a continuous trench of pervious blanket is not warranted. They are also employed to correct developed bed seepage conditions.

3.43 Elevator Tower

Tower containing lifts to give access to galleries at different elevations.

3.44 Extrados

It is the curved upstream surface of horizontal arch elements.

3.45 Fillet

A fillet is an increase in thickness of a dam at and near the abutments of the arches or the base of the cantilevers. Fillets are usually placed at the downstream face, but may also be used at the upstream edge of the base of the maximum cantilevers.

3.46 Filter

One or more layers of porous materials so arranged as to prevent movement of finer soil particles towards coarser strata by seepage flow of water (*see* Fig. 7).

3.47 Footing

Portion of the foundation of a structure that transmits loads directly to the soil.

3.48 Free Board

The vertical distance between a specified water surface and top of the non-overflow section of the dam.

3.49 Gate Chamber of Sluice Well

An opening located within the abutment or main body of the dam or the dam embankment within which the regulating gates or emergency gates are installed. The lower portion of the chamber provides an anchorage for the gates and liner, while the upper portion furnishes working space for the removal of the gate leaf and other parts for repair, and for the installation of the necessary control mechanisms. The gate chamber is usually located upstream of the axis of the dam.

3.50 Gorge

a) A small canyon,

b) A narrow passage between mountains,

c) A ravine.

3.51 Heel

The upstream edge of the base of a masonry dam. It is also called 'Upstream Toe'.

3.52 Heel Line

The line joining the upstream slope or face of a dam with the valley floor or upstream blanket. It is also called 'Upstream Toe Line'.

3.53 Height of Cantilever

It is the vertical distance between the base elevation of the cantilever section and the top of dam which may or may not be the top arch.

3.54 Hoisting Chamber

A chamber built to house remote control hoisting mechanism.

3.55 Horizontal Drainage Blanket

A blanket of pervious material constructed at the foundation from downstream toe of the impervious zone to the landside in a levee or downstream side of an earth dam, to permit the discharge of seepage flow without movement of finer soil particles and to minimize the possibility of piping failure, either of the blowout or subsurface erosion type. It is also called 'Pervious Blanket' or 'Drainge Filter'.

3.56 Hydraulic Height

The hydraulic height is the difference in elevation between the lowest point in original stream bed at the axis of the dam and the highest controlled water surface.

3.57 Impervious Blanket

A blanket which is impervious.

3.58 Insulating Wall

A thin wall of reinforced concrete provided along the downstream face of a dam and at a little distance from it with a view to protect it from frost damage in cold countries.

3.59 Intrados

It is the curved downstream surface of horizontal arch elements.

3.60 Inverted Filter

A layer or layers of pervious or semi-pervious material having a controlled gradation to provide drainage and prevent movement of finear soil particles due to seepage flow of water. It is also called 'Protective Filter'.

3.61 Irrigation Sluice

It is an opening through the body of the dam for passing water for irrigation purposes.

3.62 Key Wall

A cutoff wall extending from the cutoff trench into the bed rock or impervious subsurface stratum.

3.63 Length of Arch Dam

It is the length along a curve which is concentric with the extrados and passes through the midpoint of the arch thickness at the crown.

3.64 Length of Dam

The extent of barrier in dam and integral features constructed between excavated abutments. The length is measured along the axis of the dam at

the elevation of the top of the main body of the dam or of the roadway surface exclusive of any abutment spillway. If the spillway lies wholly within the dam and not in any area especially excavated for the spillway, the length should be the length along the axis extended through the spillway to the abutment contacts. Also called 'Crest Length'.

3.65 Line of Arch Centres

A line passing through the arch centres in plan or profile. Arch centres are located so that they will be on smooth profile curves in a vertical plane. In the case of a constant centre type of arch dam, a single vertical line will be the locus of the arch centres. For variable centre dams, separate profile curves will be the loci of arch centres for the upstream face, the centre line, and the downstream face. In the case of symmetrical layouts, the vertical plane through the arch centres will generally intersect the dam at the place of maximum deflection (*see* also **3.6**).

3.66 Main Body

The structural part of a dam above foundation.

3.67 Maximum Base Width

Horizontal distance between the outer points of the heel and toe of the cross section of a dam or spillway.

3.68 Maximum Height of Dam

See **3.93.**

3.69 Overhang

a) The portion of spillway crest of the dam projecting upstream for efficient water discharge.

b) In an arch dam, the portions projecting beyond the width of top arch.

3.70 Partial Cutoff

A cutoff extending into the underlying stratum, but not reaching an impervious subsurface stratum.

3.71 Perforated Cutoff

A nonwatertight cutoff made of material such as steel sheet piles. It is also called 'Semi-impervious Cutoff'.

3.72 Positive Cutoff or Complete Cutoff

A cutoff extending to or into the bed rock or into impermeable subsurface stratum.

3.73 Pressure Relief Well or Drain Well or Relief Well

See **3.42.**

3.74 Profile

A profile is a developed elevation of the intersection of the dam with the original ground surface, rock surface, limit of excavation, or any other surface along a designed line, such as the axis or the upstream of downstream toe. Profiles are commonly classified as U-shaped or V-shaped, with variation between these two classifications.

3.75 Protective Filter

See **3.60.**

3.76 Pulvino (Cushion)

It is a type of abutment pad provided to protect abutment rock against weathering. It acts as a transition structure between the arch and the rock, distributes the stresses on the rock or bridge over areas and of weak rock and also smoothens out any irregularities in the foundation.

3.77 Relief Well

See **3.73.**

3.78 Revetment

Material, such as rock, concrete blocks or mattresses, placed on the bottom or banks of a river to prevent or minimize erosion.

3.79 Riverside Blanket

See **3.104.**

3.80 Rock Toe

The downstream toe of an earth dam or other structure constructed of rock materials.

3.81 Section of an Arch Dam

It is that part of the arch which is selected for case of computation. The section shall have a constant extrados radius but may be variable in thickness.

3.82 Semi-impervious Cutoff

See **3.71.**

3.83 Service Outlet

Outlets provided in the body of the dam through which water is drawn off for actual use. These are provided with trash racks.

3.84 Shell

A component of an arch dam constructed of pervious or semi-pervious materials upstream and downstream of the core or membrane. The upstream portion is called 'Upstream Shell' and the downstream portion 'Downstream Shell'. Shell is also called 'Shoulder' (*see* Fig. 7).

3.85 Shoulder

See **3.84.**

3.86 Shot Concrete Cutoff

see 3.92.

3.87 Socles

It is a type of abutment pad; it varies in depth according to requirements of symmetry of the arches and excavation of the abutments and is placed as an integral part of the dam.

3.88 Sod

A surface layar of soil matted or held together by roots, rhizomes and stolons of grasses and other herbs (*see* Fig. 7). This is normally used in the downstream surface of earth dam for preventing rain cuts and is also known as 'Turfing'.

3.89 Sluice

a) A conduit, fitted with a gate, for carrying water at high velocity.

b) An opening in a structure through which anything flows, for example, water, ice or debris.

c) To cause water to flow at high velocities for wastage, for purpose of excavation, ejecting debris, transporting ways, etc.

3.90 Sluicing Outlet or Desilting Sluice

Outlet in the body of the dam, used for scouring or sluicing out settled material from the reservoir.

3.91 Stoped Cutoff

Cutoff constructed by utilising underground mining methods for excavation, then backfilling the excavation with concrete or other selected material.

3.92 Stub Concrete Cutoff

Cutoff employed in conjunction with a level rock foundations or with a deep soil trenches cutoff where a good seal of earth on rock is difficult to obtain. Its purpose is to increase to path of seepage and prevent leakage along the rock-soil contact surface.

3.93 Structural Height of Dam

It is the vertical distance between the lowest point in foundation and top of the dam. The structural height of an earth dam is the vertical distance between the top of embankment and the lowest point in the excavated foundation area, including the main cutoff trench, if any, but excluding small trenches or narrow back-filled areas whose width is less than 10 m. The top elevation does not include the crown of any roadway over the dam. The structural height of a masonry dam is the vertical distance between the top of the dam and the lowest point of the excavated foundation area, whose width is less than 10 m. The top of the dam is the crown of the roadway, if a roadway is taken over the dam, otherwise it is the level of the walkway.

3.94 Supporting Mass

The portion of the body of a dam supporting the levy-type facing.

3.95 Thickness of Arch Dam

It is the length of a line along an extrados radius from the upstream to the downstream face which passes through the point.

3.96 Thickness of Dam

Thickness of a dam at any point is the distance between the upstream and downstream face along a line normal to the axis through the point.

3.97 Thrust Block

It is an artificial abutment and can be used:

i) to reduce length of an arch near the top of a dam canyons that widen rapidly;

ii) to reduce non-symmetry;

iii) to spread the stress over wider area in case of weak abutment rock;

iv) to serve as an abutment where no natural rock abutment exists;

v) to accommodate the spillway and to locate conduits where situation requires.

3.98 Toe Drain

A drain constructed at the downstream toe of an earth dam to collect and drain away the seepage through the dam and its foundation (*see* Fig. 7).

3.99 Top Width

Width at the top of the dam.

3.100 Transition Filter

A component of an earth dam section (with core) consisting of intermediate grade of material placed between the core and the shells to function like a filter, preventing lateral movement of fines from the core (*see* Fig. 7).

3.101 Transition Zone

It is the part of the section of an earth dam occupied by the transition filters placed between two zones of an earth dam so as to prevent the lateral movement of finer particles towards the coarser zone.

3.102 Trench Drain

A drain provided in the foundations of a dam to intercept seepage. When placed immediately after a cutoff, it relieves any pressure that might develop from possible ineffectiveness of the cutoff.

3.103 Turfing

See 3.8.

3.104 Upstream Blanket

An impervious blanket constructed from the upstream toe of impervious zone towards the

upstream of an earth dam or towards riverside of a levee (then called 'Riverside Blanket') where substratum is pervious, to control seepage by increasing the resistance to seepage entry into the pervious substratum, thereby decreasing both seepage flow and excess pressure downstream side of the earth dam or landward side of the levee (*see* Fig. 7).

3.105 Upstream Shell or Upstream Fill

See **3.84.**

3.106 Upstream Toe

See **3.51.**

3.107 Upstream Toe Line

See **3.52.**

3.108 Valley Shape

It is the ratio of the width of the valley at crest level of dam to the depth of the valley below crest level, it is also called canyon shape.

3.109 Voussoir

It is that smaller segment of a section of an arch which, for ease of computation, is assumed to have constant thickness.

4 TERMS RELATING TO GALLERIES AND OTHER OPENING IN THE DAMS

4.1 Access Gallery

A horizontal gallery connecting the gallery system in the dam with the downstream face or features outside the dam, such as power house or gate house. Also called 'Adit' or 'Entrance Gallery' (*see* Fig. 9)

4.2 Adit

See **4.1.**

4.3 Drainage Gallery

A gallery in a masonry dam, parallel to the crest to intercept seepage from the water face and conduct it away from the downstream face.

4.4 Entrance Gallery

See **4.1.**

4.5 Foundation Gallery

A gallery providing drainage for water percolating from the upstream face or seeping through the foundations in a dam, generally extending the length of the dam near the rock surface, conforming in elevation to the transverse profile of the canyon; in plan it is near and parallel to the axis of the dam. It is from this gallery that the holes for the main grout curtain are drilled and grouted, and also from which foundation drain holes are drilled.

4.6 Gallery

A passageway in a dam for obtaining access to interior parts, or to carry pipes or to house machinery.

4.7 Gate Gallery

Gallery, made in a dam, to provide access to and room for, the mechanical equipment required for the operation of gates in outlet conduits, power penstocks or spillway crests.

4.8 Grouting Gallery

Gallery provided in a dam to locate the supply, return and vent headers of the grout piping system; also the piping system for artificial cooling of the blocks terminates in the galleries.

4.9 Inspection Gallery

Gallery made in a dam to provide access to the interior of the mass in order to inspect the structure and study the structural behaviour of the dam after completion. Foundation, drainage gate and grouting galleries also serve as inspection galleries (*see* Fig. 9).

4.10 Plum-Line Shaft or Collimator Shaft

A shaft located near the maximum section of a dam in order to make observations of the movements of the dam with respect to the base.

4.11 Shaft

Vertical openings provided in the dam at suitable places for various purposes, such as for location of headers of artificial cooling system, accommodation for measuring devices, for connecting galleries by stairway, for elevator movement and for hoisting equipment for inspection purpose

4.12 Stilling Well Shaft

A special shaft, sometimes, included in the design of a dam, open to the reservoir below minimum reservoir level and containing a floating mechanism to record reservoir fluctuations.

4.13 Spillway Tunnel

A tunnel used as a spillway outlet.

4.14 Weep Holes

Holes used for reduction of uplift pressure under aprons and excessive pressure behind walls.

5 TERMS RELATING TO APPURTENANT WORKS TO A DAM

5.1 Bye-Pass Outlet

It is a sluice provided in a dam to bye-pass water to flow from reservoir to canal or river downstream, when power house is not functioning.

5.2 Divide Wall

A wall extending along the spillway to separate overflowing water, wherever necessary.

5.3 Drainage Hole

Holes drilled into the dam foundations for relieving uplift pressures.

5.4 Emergency Gate

Gates used for controlling flow through sluices when any repairs or maintenance or both are required to be carried out to service gates. These are generally designed for full gate opening.

5.5 Fish Ladder

Structure constructed for allowing fish from river downstream pass up into the reservoir.

5.6 Penstock

Pressure pipes usually made of steel which convey water from the intake to the turbine in hydroelectric power-house.

5.7 Pier

Concrete or masonry structure constructed over the spillways for supporting bridge decking, spillway gates and hoist operating mechanism.

5.8 Power House

A building housing the generating and controlling equipment of a hydroelectric power generation system.

5.9 Retaining Wall

Concrete or masonry wall constructed to retain backfill or water.

5.10 Sluice Gate or Service Gate

Gates used for allowing water to flow through, from the reservoir to downstream at a controlled rate.

5.11 Training Wall

Concrete or masonry wall constructed on overflow section of the dam to guide the spillway water.

5.12 Trash Rack

A grill or cement over at intake openings for preventing the entry of suspended or floating material into the water conductor system. Trash for fine/coarse openings depending upon the nature of the debris to be included.

6 TERMS RELATING TO JOINTS

6.1 Asphalt Seal

Asphalt filler in a contraction or expansion joint filled with asphalt to make it watertight.

6.2 Block

The portion of a dam between two transverse joints constructed normal to the axis.

6.3 Closure Block or Closure Gap

Closing gaps are provided in between blocks for adverse conditions due to temperature effects, foundation requirements, unusual size of the structure and in stage construction. These are named as shear slots twist slots depending upon the function.

6.4 Construction Joint

The interface between the two successive placings of earth masonry or concrete where bond (and not permanent separation) is intended. These are classified into horizontal joints, transverse joints and longitudinal joints (*see* Fig. 9).

6.5 Contraction Joint

A joint provided to localise and minimize development of cracks due to drying shrinkage and thermal variations.

6.6 Expansion Joint

A joint provided in exposed members between fixed points to permit longitudinal expansion and contraction when changes in temperature occur, and to permit vertical movement where differential settlement is anticipated.

6.7 Grout Stop

A type of waterstop to confine the extent of grouting used to seal joints.

6.8 Horizontal Joint or Construction Lift

A joint introduced between the lifts to provide sufficient cooling between pours.

6.9 Joints

A break between two pours of concrete done at some interval of time; or a small open space forming a complete plane of separation between component of the structure with relation to transmission of stresses.

6.10 Joint Drain

Vertical drains provided in transverse or construction joints as a precaution against development of excessive pressure in the joints during the construction period and against seepage of reservoir water through the joints during the operating period (*see* Fig. 9).

6.11 Keyways or Offsets

Indentations or projections of some geometrical shape built on, or formed into, poured surfaces to provide a degree of integral action with subsequent structural additions.

6.12 Lift

The height, which is poured continuously at any time and over which other lift is poured after sufficient time is allowed for the pour to cool.

6.13 Longitudinal Construction Joint

See **6.13.**

6.14 Longitudinal Joint

a) A joint in the longitudinal direction of the dam or parallel to the axis of the dam and offset at the transverse joints to form a longitudinal row of staggered columns,

b) Joint parallel to the lines of principal stress. It is also called 'Longitudinal Construction Joint'.

6.15 Perimetral Joint

It is a joint provided between the dam and the foundation pad or pulvino, commonly known as pulvino perimetral joint. This joint is provided for lower and better distribution of stresses. It also relieves tensile stress in the abutment extrados.

6.16 Polyvinyl Chloride Seals

A type of seal manufactured in different shapes from the polyvinyl chloride material.

6.17 Seal

These are used to prevent the leakage of water from the reservoir to the downstream face through transverse construction joints between construction blocks.

6.18 Sealing Strips

See **6.22.**

6.19 Shear Key or Shear Slot

These are regular projections provided in joints in dam for transfer of load from one block to other through shear. The shear keys in transverse joints are designed to transfer horizontal shear and those in longitudinal joints are designed to take vertical shear.

6.20 Transverse Contraction Joint

See **6.21.**

6.61 Transverse Joint

A joint provided normal to the axis of the dam and extending entirely through the structure dividing it (structure) into separate blocks, with a view to preventing haphazard transverse cracking due to contractions of concrete. Also called 'Transverse Contraction Joint'.

6.22 Transverse Joint Seals

Device provided in the transverse joint to prevent leakage of water from the reservoir. These seals are of copper, rubber, etc. Also called 'Sealing Strips'.

6.23 Vertical Drains

See **6.10.**

6.24 Vertical Wells

See **6.10.**

6.25 Water Stops

Devices provided to prevent the flow of water through the leaks or joints.

7 TERMS RELATING TO GROUTING, FOUNDATIONS TREATMENT AND DRAINAGE

7.1 Alluvium Grouting

Grouting of transported pervious media, such as sand, gravel and single, with clay, cement, bentonite and/or chemicals mixed in different proportions.

7.2 Area Grouting

In cases where large zones of fractured rock, lie at the foundation contact or where the zone of broken rock within a fault has great width, the entire zone of factured rock shall be grouted to a shallow depth usually 3 to 10 m by using a grid pattern. This type of grouting is referred to as blanket grouting. It reduces leakage in the fractured zone and provides a more firm foundation for the dam.

7.3 Bentonite Grouting

Grouting in which bentonite with or without other ingredients in the form of suspension is injected under pressure into a pervious medium to make it watertight.

7.4 Circulating System

The piping arrangement by which grout is conveyed from the grout pump to the grout hole and through a return line from the hole to the grout pump.

7.5 Chemical Grouting

Grouting in which chemicals are injected under pressure into a pervious medium to make it watertight by formation of gels.

7.6 Contact Grouting

Contact grouting is a sealing operation intended to bring about as nearly as possible a fully bounded contact between any concrete structure and the adjacent rock.

7.7 Curtain Grouting

It consists of forming an approximately vertical grout curtain of moderate thickness below a dam to control seepage of water.

7.8 Dental Treatment

It consists of excavating objectionable materials from solution cavities, fault zones, seams or other rock imperfections and filling with concrete the cavities so excavated.

7.9 Drainage

It is the disposal of surface and seepage water in the abutments, foundation and the body of the dam.

7.10 Foundation Drainage Holes

Holes drilled from the foundation gallery or drainage gallery of dam into the foundation, downstream of high pressure grout curtain to intercept seepage through the curtain and thus to relieve uplift pressure.

7.11 Full Depth Grouting

A method of grouting in which the entire depth of a hole is grouted in one operation by connecting the grout supply line to the manifold at the top of the hole.

7.12 Grout

A fluid or fluid mixture that can be poured or injected easily.

7.13 Grout Curtain

A diaphragm or curtain in which the foundation is made impervious by grouting process.

7.14 Grouting

A process of pouring or injecting grout in the joints, hollows, cracks, seams, faults, shattered zones or fracture zones, etc.

7.15 Guniting

A process of laying membrane of an intimate mixture of sand and cement pneumatically conveyed in a dry state to the nozzle of the cement gun where water is added immediately prior to expulsion and shot into place.

7.16 Internal Drainage of Dam

It usually comprises porous concrete blocks/formed drains at the contraction joints and in the body of the dam.

7.17 Joint Grouting

Joint grouting consists in grouting construction joints between adjacent units of a concrete structure in order to join them together into a single unit.

7.18 Manifold or Header

The piping arrangement at the top of the hole for connecting the line to the hole.

7.19 Multiple Grouting

A thick grout is occasionally used during the first stage to seal leaks; as soon as the grout in the rock has attained a partial set the hole is washed and redrilled then regrouted with a thinner mix.

7.20 Packer

The device used in the hole to segregate part of a hole for grouting or percolation testing.

7.21 Packer Grouting

The use of expandable implements, such as packers, to isolate sections of a grout hole and thereby enable the application of grout, under pressure only, in a portion of the hole.

7.22 Pattern

Arrangement of holes in plan and vertical section.

7.23 Percolation Test

Pumping of water into a hole with or without pressure through a direct connection or in different sections of hole using packers and measuring water intake for determining permeability characteristics. It is also called 'Water Percolation Test'.

7.24 Porous Concrete Drains/Formed Drains

These drains are provided to intercept the seepage water and such seepage water shall ultimately be let out into drainage gallery system. For masonry dams, drains through porous concrete blocks are provided and for conerete dams there shall be formed drains.

7.25 Pressure Grouting

It is a process of injecting under pressure, a fluid sealing material into the inaccessible formations or places through specially drilled holes for the purpose of sealing off or filling joint seams fissures or any other openings.

7.26 Primary Holes

In split spacing grouting the first set of holes are referred to as 'Original Holes' or 'Primary Holes'.

7.27 Rip-Rap

It is the layer of large size blocks of rock or concrete over the top surface of earth or rockfill section of the dam to protect the underlying layer from erosion.

7.28 Shear Key

A longitudinal trench in the foundation of concrete/masonry dam and backfilled with concrete in order to increase the resistance against sliding.

7.29 Single Line System

The piping arrangement by which grout is conveyed from a grout pump to grout hole through a single line of pipe without a return line.

7.30 Single Stage Grouting

Same as 'Full Depth Grouting'.

7.31 Split Spacing Grouting Method

A sequence of drilling and grouting holes in which widely spaced holes and drilled and grouted initially and the spacing is sub-divided by intermediate holes. The initial set of holes are called primary holes and intermediate holes are termed as secondary, tertiary, etc, according to the sequence of subdivision.

7.32 Stage

A partial depth of holes treated or to be treated.

7.33 Stage Grouting

Grouting consisting of drilling a hole to a limited depth or to the intersection with an open seam, grouting to that depth, cleaning out the hole after the grout has taken its initial set, and then drilling and grouting the next stage. The process is repeated, using higher pressures for each successive stage until the final depth is reached. Also known as 'Down-stage Grouting' or 'Successive Grouting'.

7.34 Subsurface Drainage

It is provided for slope protection and along abutments so as to relieve building up of water pressure behind the dam and the appurtenant works.

7.35 Successive Grouting

See **7.33.**

7.36 Surface Drainage

It is provided for all open surfaces of the dam.

7.37 Washing

Washing of the walls of the grout hole by water under pressure after completion of drilling but before grout injection.

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Central : Manan Bhavan, 9 Bhadur Shah Zafar Marg NEW DELHI 110002	{331 01 31 331 13 75
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Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036	53 38 43
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